

SF6 Gas Handling Procedure

1. Introduction

This module lists procedures required to safely perform installation, inspection, and maintenance work on sulfur hexafluoride (SF6) gas-insulated apparatus.

In common with numerous other chemicals used everyday in industry, SF6 gas and its decomposition products present no injury or illness problems if dealt with properly. As with other chemicals, health hazards may exist under particular conditions, if exposure or handling is careless or improper. All personnel designated to perform inspection or maintenance work on ABB SF6-insulated apparatus should read this module and follow all of the instructions herein.

1.1 Properties of SF6 Gas

In its pure, natural state, SF6 gas is colorless, odorless, and tasteless and possesses a low order of toxicity. The only danger in breathing pure SF6 gas is that it displaces oxygen and can cause suffocation. SF6 gas is chemically inert and non-flammable. The gas has a high dielectric strength and thermal properties conducive for insulating high voltage and quenching electrical arcs.

Refer to the addendum (at the end of this module) from the manufacturer for specific chemical details.

If SF6 gas is subjected to an electric arc heat causes the gas to decompose into potentially toxic by-products. (This gas also decomposes when exposed to other high temperature conditions such as heater filaments, smoking, welding, etc.) Fluorides of sulfur are the most toxic decomposition products and are in gaseous form. A molecular sieve (desiccant bag) containing activated alumina is provided in each pole tank. This molecular sieve eliminates most of these gaseous decomposition products. The less toxic metal fluorides are in the form of white, tan or gray powder. The amount of decomposition of the gas is a function of the intensity and duration of the arc.

Some of the SF6 decomposition products form corrosive and conductive compounds when exposed to moisture. These compounds, which can be harmful to human beings, are also aggressive towards materials within the circuit breaker, especially insulating surfaces if subjected to prolonged exposure. That's why it's best not to perform breaker maintenance on rainy, humid days.

By weight SF6 gas is approximately five times heavier than air and tends to diffuse towards the pull of gravity and pools in low places. As a result of this pooling, the gas displaces oxygen and can cause suffocation without warning if the oxygen content of air is reduced from the normal 20 percent to less than 13 percent.

In the presence of moist air, noxious decomposition products have a characteristic odor of rotten eggs.

SF6 Gas Handling Procedure

DANGER

Since SF6 gas displaces oxygen, avoid inhaling SF6 gas. Oxygen deficiency can cause nausea and drowsiness. Prolonged exposure to this gas in a confined space can cause serious breathing difficulty and suffocation.

Avoid skin or eye contact with the decomposition products because they can cause skin rashes, eye irritation, and chemical burns.

In the presence of moist air, noxious decomposition products have a characteristic odor of rotten eggs. Avoid inhaling these by-products because, unprotected prolonged exposure can injure the respiratory tract. Wear the prescribed protective gear indicated in sections 1.2.1 and 3.

1.2 Equipment Used to Handle SF6 Decomposition Products

The following equipment is used to perform maintenance on SF6 gas-insulated apparatus where decomposition products may be present:

- Hooded disposable coveralls – Tyvec, Durafab or equivalent-made of paper with nylon reinforcement material;
- Non-Disposable Neoprene Gloves – 14inch size;
- Non-Disposable Rubber Boots – 17 inch size over-the-shoe style;
- Clean, oil-free dry air supply with a capability to provide sufficient purging and ventilating capacity;
- Full-face Comfo II respirator or equivalent with twin cartridges for organic vapors and acid gases, i.e., GMC or equivalent;
- Supplied air-line respirator-MSA pressure demand type with Ultravue face piece and web bell-mounted demand respirator, 50 ft. of air supply hose, manifold with quick-disconnect and automatic shut-off outlets, cylinder pressure regulator, must have NIOSH/MESA approval No. TC-19C-93 or equivalent from other manufacturer;
- Respiratory compress air supply-300 lb. Approved portable tank with air meeting Grade D, ANSI Standard Z96.1-1974 with supply hose ideal pressure between 80 to 100 psig;
- Industrial wet or dry type vacuum cleaner with non-metallic attachments, micro staphicidal filter elements (particles to 0.3 microns) two 15-inch lengths of plastic hose and coupler;
- Cleaning solvent: denatured ethyl alcohol.

1.2.1 Protective Gear

Minimum required protective gear to be worn while handling SF6 gas-insulated apparatus are:

- Gloves;
- Full-face Comfo II respirator or equivalent with twin cartridges for organic vapors and acid gases, i.e., GMC or equivalent;

SF6 Gas Handling Procedure

Full protective gear includes:

- Gloves;
- Hooded disposable coveralls;
- Non-Disposable Neoprene Gloves – 14 inch
- Non-Disposable Robber Boots – 17 inch, over-the-shoe style;
- Supplied air-line respirator.

2. SF6 Gas Handling Safety Practices

Safety practices when handling SF6 gas-insulated apparatus are:

- Perform SF6 gas handling, filling or reclaiming outdoors;
- If procedures involving SF6 gas insulated equipment must be done indoors, work in a well-ventilated room; make sure the ventilating equipment is operating;
- No smoking;
- No exposed heaters, flames, or arc-producing equipment should be used in the area while the gas is being handled;
- If-when handling used SF6 gas, the odor of rotten eggs is detected, personnel not wearing respiratory equipment should promptly evacuate the area;
- Correct any gas leaks at hose or filling connection at the breaker, on the service cart, or at the cylinder.

2.1 Storing SF6 Gas Cylinders

Pressurized cylinders, which contain SF6 gas, can be damaged or ruptured by careless handling.

Requirements for storing gas cylinders include:

- Store cylinders in a well-ventilated area;
- Secure the cylinders in a way to prevent them from falling or being knocked over.

2.1.1 Heating an SF6 Gas Cylinder

When filling during cold ambient temperatures, the cylinder may be heated any of the following methods to convert the liquid SF6 in the cylinder to a gaseous state:

- An electric blanket heater;
- Immersing the gas cylinder upright in a drum partially filled with warm water so that approximately half of the cylinder is immersed. Heat the water with a portable gas or electric heater.

SF6 Gas Handling Procedure

WARNING

Never heat a gas cylinder with an open flame.

Energize heaters only when transferring the gas. When handling the cylinder, be sure that the temperature in the cylinder does not exceed 100°F (38°C).

3. Maintenance of SF6 Gas Insulated Apparatus

After an SF6 electrical apparatus has been in service, it should be assumed that hazardous decomposition might be present.

Before performing any maintenance on SF6 gas-insulated apparatus, review sections 1 and 2 of this module. Perform the initial inspection of the apparatus wearing at a minimum, gloves and a full-face respirator. If significant amounts of solid decomposition products or noxious gases are present when opening a pole unit, wear full protective gear (as listed in section 1.2.1) and proceed as per section 3.1.

If a tent-like enclosure is used around the apparatus, use a dry air ventilation system while performing maintenance work.

If no decomposition products are found:

1. Purge the apparatus thoroughly with dry air from a suitable source.

Important: Do not purge with damp or set air as it can endanger the integrity of insulation materials and prolong dry-out and reconditioning time.

It is only safe to assume that there may be hazardous gaseous products present. All personnel should stand clear of the apparatus during purging.

2. Allow purging to continue long enough to assure a minimum of at least 10 complete air changes through the total apparatus before working on the equipment. If the SF6 gas has not been fully evacuated from the apparatus prior to purging, perform a minimum of 100 air changes.
3. Reduce the purging air supply to a low level (approximately 10 air changes per hour) to provide continuous ventilation of the apparatus while personnel are working internally in the apparatus.

3.1 Removing SF6 Decomposition Products

If significant arc powders or noxious odors are detected upon opening a pole unit or any other apparatus:

1. Wear full protective clothing and a supplied air full-face respirator.

SF6 Gas Handling Procedure

2. Establish a restricted safety zone around the equipment. Personnel cannot enter this zone without wearing full protective gear (defined in section 1.2.1). If performing this work outdoors, the zone may need to be extended downwind of the work site.
3. Use a vacuum cleaner equipped with filters as described in section 1.2; this vacuum cleaner should be used exclusively for removing SF6 decomposition products.
4. Wipe up any remaining powdered decomposition products with rags using denatured ethyl alcohol.
5. Remove and dispose the molecular sieve (desiccant) within the apparatus as per section 4; keep the full protective gear on.
6. Place materials used and retrieved in clean-up operations in large plastic or metal containers. These containers serve as refuse containers.
7. Proceed with purging as per section 3 after removing all decomposition products.

4. Disposing of Decomposition Products

Dispose of decomposition products outdoors since corrosive or toxic gases may evolve from the solid arc products or from the molecular sieve (desiccant). Disposal of the SF6 residue involves neutralizing the decomposition products.

Notice: Wear full protective gear as per section 1.2.1 during disposal.

To properly dispose of decomposition product residue:

1. Place materials used and retrieved in clean-up operations in large plastic or metal containers. These containers serve as refuse containers.
2. Empty the vacuum cleaner housing and the absorption filter material into the container.
3. Note or measure the volume of material in the containers.
4. In a separate container (plastic pail), measure a volume of water 1.5 times that of the above refuse material. Empty the water into the refuse container pouring the water quickly at first then slowly. The water mixing with the SF6 refuse will produce some heat and foam.
5. Measure a quantity of soda ash (sodium carbonate) or lime (calcium oxide) equal to at least one-quarter the volume of the refuse and add this neutralizing agent to the water-refuse material.

SF6 Gas Handling Procedure

6. Add the cleaning rags, protective clothing (even though it is disposable), along with the filters from the vacuum cleaner and respirator to the neutralizing mixture in the refuse container.
7. Allow the refuse container to stand uncovered for 24 hours.
8. Afterwards test the pH of the refuse mixture.

The mixture should be at least slightly alkaline (greater than 7). If the pH is between 7 and 10, the refuse is now rendered harmless and may be disposed of in a normal manner as per local ordinances.

If the solution pH is less than 7, it is still acidic and harmful; add soda ash or lime to neutralize the refuse mixture to a pH greater than 7 but less than 10. Then dispose of the material as per local ordinances.

4.1 Removing SF6 Gas Residue from Tools and Equipment

To clean tools and equipment that have been exposed to SF6 decomposition products:

1. Prepare a mild (10%) lime or soda ash solution and use this as the neutralizing solution.
2. Wash any hand tools, non-disposable protective gear, and equipment employed in the clean-up operation.
3. Vacuum some of this neutralizing solution through the hose and into the vacuum cleaner to neutralize particles adhering to this equipment.
4. Rinse all washed tools and equipment thoroughly with water.
5. Wash the rubber boots and Neoprene gloves in water.